

California Renewable Diesel Multimedia Evaluation Tier I Report



**December 8, 2010
Biodiesel Workshop**

**Tom McKone, University of California, Berkeley
Tim Ginn, University of California, Davis
Dave Rice, Consultant to University of California**



Renewable Diesel Tier I Elements



- **Background**
- **Study Approach—Life Cycle and Multimedia**
- **Release Scenarios**
- **Renewable Diesel Production, Storage, Distribution and Use**
- **Renewable Diesel Toxicity**
- **Transport and Fate**
- **Tier I Conclusions**

Slide 2

December 8, 2009



Background

- Currently the majority of biological-source diesel fuels are fatty-acid methyl esters (FAME)
- Renewable diesel is different and now entering the market
- According to the Low-Carbon Fuel Standard (LCFS)

“... a motor vehicle fuel or fuel additive which is all the following:

(A) Registered as a motor vehicle fuel or fuel additive under 40 CFR part 79; A-9

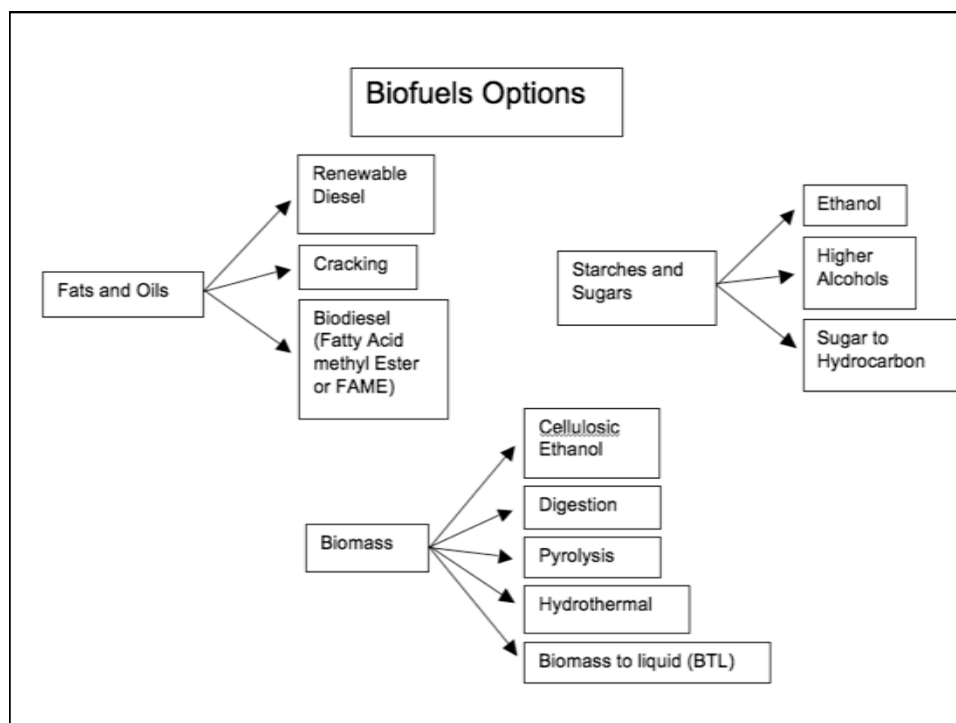
(B) Not a mono-alkyl ester;

(C) Intended for use in engines that are designed to run on conventional diesel fuel; and

(D) Derived from nonpetroleum renewable resources.”

Slide 3

December 8, 2009



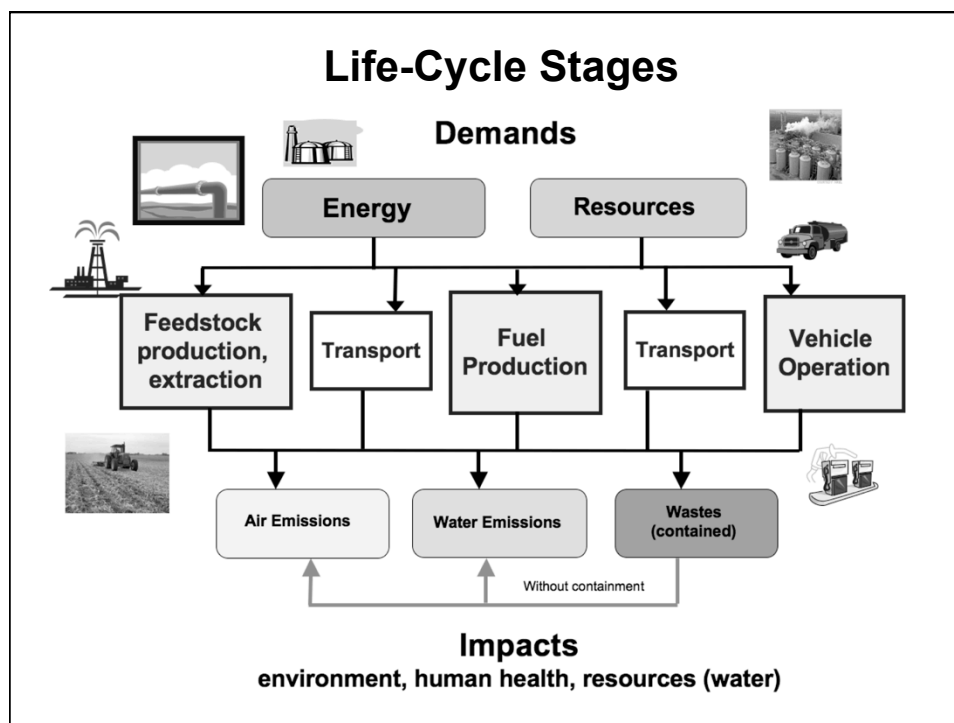


Study Approach

- **Life-cycle approach to impacts**
 - Human health
 - Ecological risk
 - Resource stress and damage
- **Identify key uncertainties and data gaps**
- **Address multimedia impacts**
 - Air quality
 - Water resources
 - Soil
 - Infrastructure
- **Excludes indirect environmental, ecological, and health impacts from biomass production (i.e. climate disruption)**

Slide 5

December 8, 2009





Key LCA Studies Review



- **US EPA Life Cycle Assessment of Renewable Fuels**
 - As part of its RFS2 rulemaking, EPA made a life cycle assessment of alternative and petroleum transportation fuels
 - EPA reported fuel use and production emissions
- **National Research Council “Hidden Costs of Energy” Study (2009)**
 - Life-cycle damage per vehicle-mile traveled (VMT)
 - Different combinations of fuels and vehicle technologies
 - VMT damages were remarkably similar
 - NRC urged caution interpreting small differences between fuel/vehicle combinations

Slide 7

December 8, 2009



Release Scenarios



- **Normal releases**
 - **Production emissions (in addition to refinery operation)**
 - ✧ Hexane or CO₂ released to the air during seed extraction,
 - ✧ Odors associated with waste biomass
 - ✧ Used process water discharges (pH and trace-chemicals)
 - **Use-phase (combustion) emissions**
 - ✧ Tailpipe emissions
 - ✧ Marine engine water releases
- **Off-normal releases—effectively the same as ULSD**
 - **Spills and leaks during production, distribution, and storage**
 - ✧ Above- or below-ground storage tank & associated piping,
 - ✧ Liquid-transportation vehicles--rail tank car, tanker truck, tanker ship
 - ✧ Bulk-fuel transport pipeline

Slide 8

December 8, 2009



Production, Distribution, Storage and Use



- **Approaches to producing renewable diesel (RD)**
 - Hydrotreating vegetable oils or animal fats to make Hydrogenation Derived Renewable Diesel (HDRD)
 - Partially combusting a biomass to get CO/H₂ (syngas) utilizing the Fischer-Tropsch reaction to produce complex hydrocarbons
 - Emerging approaches based on synthesis of hydrocarbons through enzymatic reactions
- **Producing HDRD**
 - Co-processing in a conventional petroleum production stream
 - Dedicated HDRD (or R100) production with distribution, direct use or dilution
- **Specifications for additives to RD expected to be similar to ULSD**

Slide 9

December 8, 2009



Production, Distribution, Storage and Use



- **Combustion emissions studies are ongoing**
- **Preliminary results suggest Renewable Diesel (RD) emissions & impacts that are within the range of ULSD emissions & impacts**
 - Absence of sulfur and aromatic compounds in pure RD
 - Pure HDRD fuel showed significant emission benefits for CO, HC, NO_x and PM—Secondary PM not yet addressed
Below 10% RD, blends can result in CO and HC reductions, but not PM, NO_x
 - Volumetric fuel consumption is 5% higher because of lower HDRD density
 - HDRD fuels avoid some biodiesel issues (oxidation, hygroscopicity, fouling, catalyst deactivation, etc).

Slide 10

December 8, 2009



Toxicity



- **Key challenge**
 - RD is not a defined chemical formulation or a defined mixture of components
- **Limited tests indicate that RD has low relative toxicity**
 - Major differences in health and ecological impact between existing diesel and RD blends are more likely to be associated with additives than with the hydrocarbon mix
 - Chemical comparison to conventional diesel is important for determining whether or how much additional toxicity tests are required

Slide 11

December 8, 2009



Transport and Fate



- The fate and transport of a fuel and its component chemicals in the environment depend on the multimedia transport properties of its constituent chemicals
- Based on similarities in chemical composition, the multimedia environmental behavior of renewable diesel should be similar to ULSD
- Impact of additives to fate and transport need to be evaluated

Slide 12

December 8, 2009



Tier I Conclusions



- **Renewable diesel (RD) is chemically similar to the ultra-low sulfur diesel (ULSD) fuel already in wide use in California**
- **RD is compatible with existing refining and distribution infrastructure and can be used in current diesel engines without modification**
- **Pure renewable diesel has reduced aromatic hydrocarbon content**
- **Limited toxicity testing on rats reveals that pure RD has limited inherent toxicity and unlikely to exceed the inherent toxicity or mutagenicity of standard diesel.**
- **Life-cycle health impacts of renewable diesel blends are not likely to differ significantly from those of petroleum diesel.**

Slide 13

December 8, 2009



Tier I Conclusions



- **Knowledge gaps include**
 - **Additive impacts**
 - **Production, storage and distribution releases (off-normal)**
 - **Air emissions toxicity testing**
 - **Priority list of renewable diesel fuel formulations**

Slide 14

December 8, 2009